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A NEW CLASSIFICATION OF CLIMATES

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[With separate map, Pl. II, facing p. 188.]

It may truthfully be said that of the making of classifications of climate there is no end. An almost infinite number may be proposed, for the basis of subdivision may be the special conditions of any one climatic element; or similar combinations of two or more elements; or, again, the distinguishing characteristics may be found in botanical or in zoölogical relations. In a previous discussion by the present reviewer, the most important classifications of climates suggested before 1906 were considered.[1] A further paper dealt chiefly with the "thermal regions" suggested by the late Dr. A. J. Herbertson.[2]

KÖPPEN'S CLASSIFICATIONS OF 1900 AND 1918

Among the numerous classifications of climate hitherto proposed, that of Dr. W. Köppen is especially noteworthy because of its emphasis upon certain critical and clearly defined underlying controls which serve as the basis of the subdivisions, because of the care with which these fundamental controls are worked out, and because of the simple way in which they are expressed.[3]

After an interval of nearly twenty years, Dr. Köppen now gives us a new, thoroughly revised classification,[4] which is clearly the result of further very searching analysis of all the most critical climatic controls, as well as of a study of other classifications which have been suggested during the intervening two decades, viz. those of De Martonne (1909), Penck (1910), Hettner (1911), and Drude (1913).

A comparison of Köppen's earlier map with the new one shows many resemblances, both in the larger climatic belts and in the smaller subdivisions. There are also certain broad resemblances in the general scheme of fundamental controls selected as the basis of the subdivisions. The new scheme is based upon temperature, rainfall, and seasonal characteristics. The critical features of the various combinations of these controls are

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[1] R. DeC. Ward: The Classification of Climates, *Bull. Amer. Geogr. Soc.*, Vol. 38, 1906, pp. 465-477.

[2] *Idem:* A Note on the Classification of Climates, *ibid.*, Vol. 46, 1914, pp. 108-116.

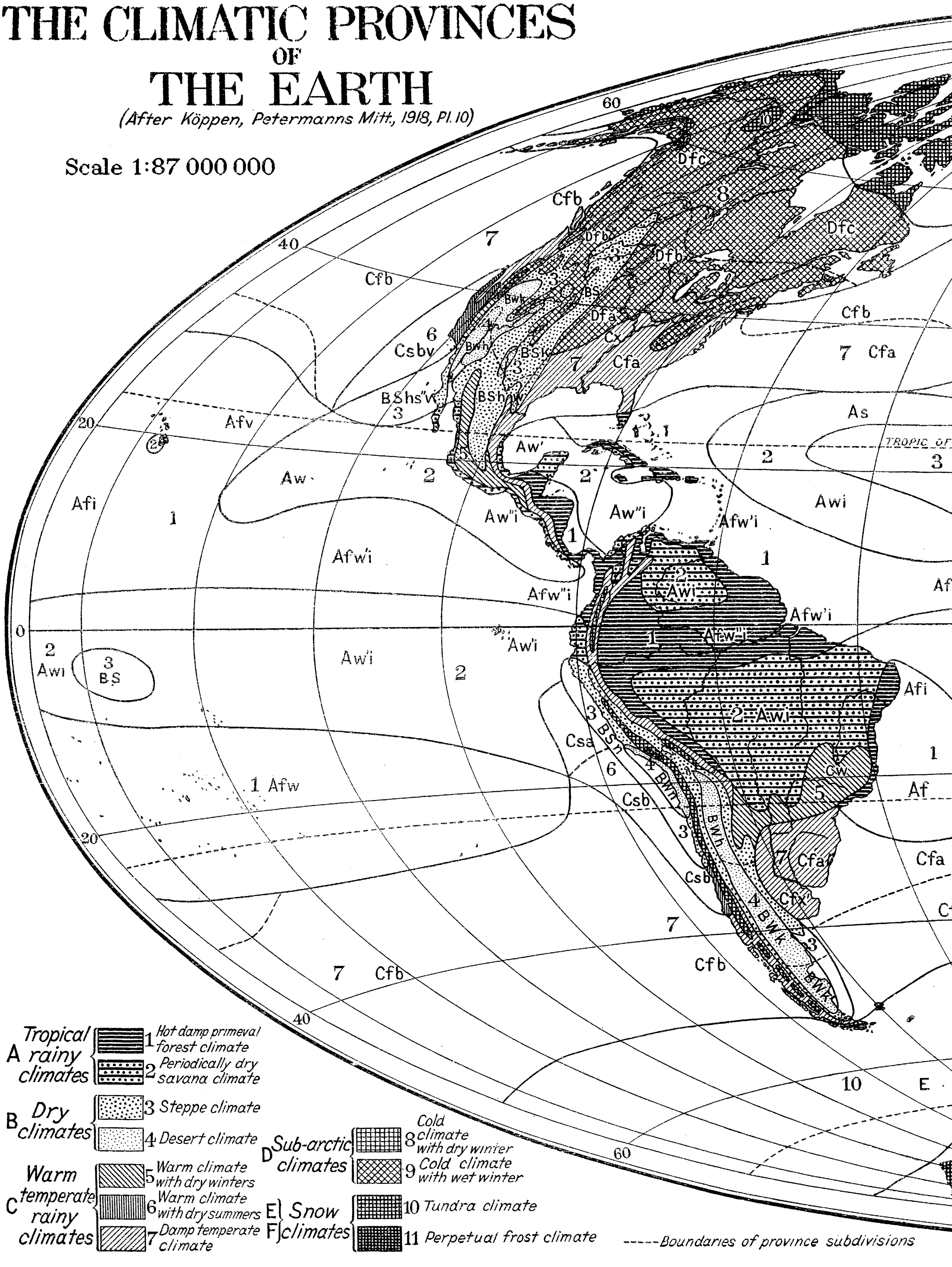
[3] W. Köppen: Versuch einer Klassifikation der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt, *Geogr. Zeitschr.*, Vol. 6, 1900, pp. 593-611, 657-679, with Pls. 6 and 7. The map has been reproduced in *Bull. Amer. Geogr. Soc.*, Vol. 38, 1906, opposite p. 468, and also in R. DeC. Ward's "Climate Considered Especially in Relation to Man," 2nd edit., 1918, p. 69.

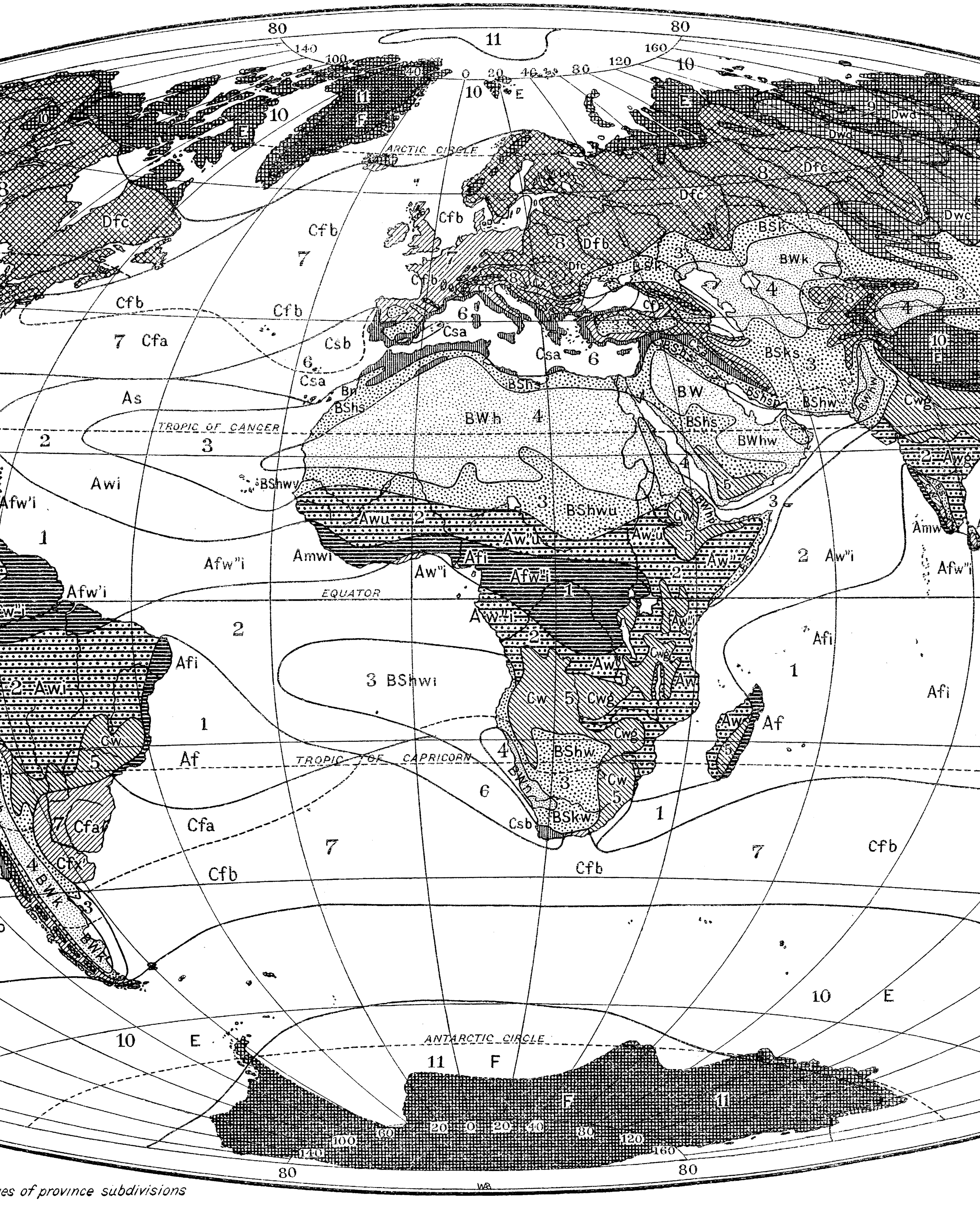
[4] W. Köppen: Klassifikation der Klimate nach Temperatur, Niederschlag und Jahresverlauf, *Petermanns Mitt.*, Vol. 64, 1918, pp. 193-203 and 243-248, with map and diagrams.

THE CLIMATIC PROVINCES
OF
THE EARTH

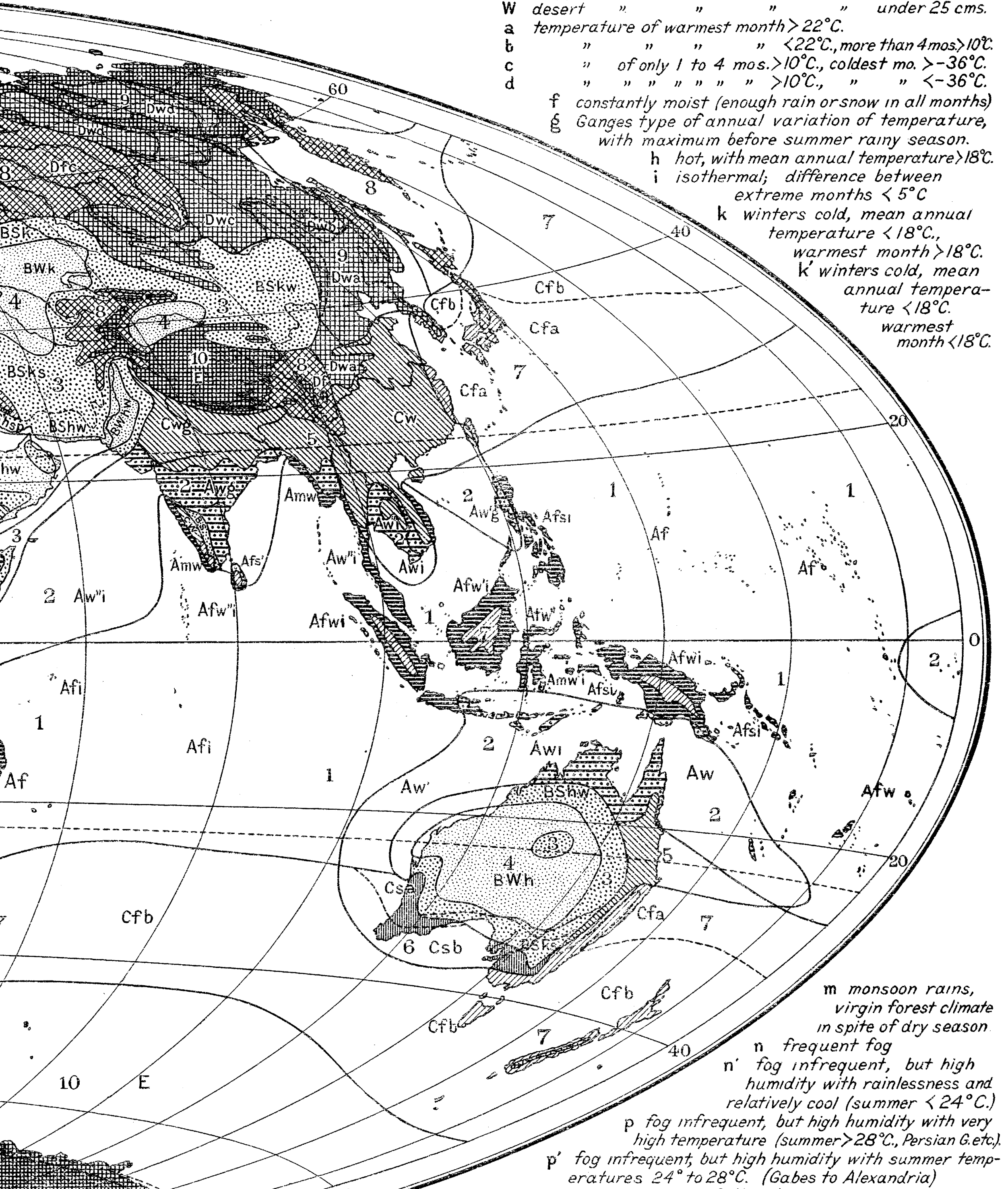
(After Köppen, Petermanns Mitt, 1918, Pl. 10)

Scale 1:87 000 000





es of province subdivisions



S	steppe climate, reduced rainfall amount 25 to 50 cms.
W	desert " " " " under 25 cms.
a	temperature of warmest month > 22°C.
b	" " " " < 22°C., more than 4 mos. > 10°C.
c	" of only 1 to 4 mos. > 10°C., coldest mo. > −36°C.
d	" " " " " " " > 10°C., " " < −36°C.
f	constantly moist (enough rain or snow in all months)
g	Ganges type of annual variation of temperature, with maximum before summer rainy season.
h	hot, with mean annual temperature > 18°C.
i	isothermal; difference between extreme months < 5°C
k	winters cold, mean annual temperature < 18°C., warmest month > 18°C.
k'	winters cold, mean annual temperature < 18°C. warmest month < 18°C.
m	monsoon rains, virgin forest climate in spite of dry season
n	frequent fog
n'	fog infrequent, but high humidity with rainlessness and relatively cool (summer < 24°C.)
p	fog infrequent, but high humidity with very high temperature (summer > 28°C., Persian G. etc.).
p'	fog infrequent, but high humidity with summer temperatures 24° to 28°C. (Gabes to Alexandria)
s	driest season in summer of that hemisphere
w	" " " winter " " "
s w'	the same, rainy season shifted into autumn
s'' w''	" " " " in two parts, with short dry season intervening.
u	(reversed) Sudan type of temperature variation, with coolest month after the summer solstice
v	Cape Verde " " " " " warmest season shifted into autumn.

worked out with great accuracy and detail, and a brief, simple, and easily remembered scheme of letters and numbers—of "climatic formulae"—is used for the characterization of each climatic subdivision. One point in connection with this classification which deserves special mention is the fact that the oceans are included in it. This is one of the distinctive features of the new scheme, as it was of the original map of 1900, and adds greatly to its interest and value. The 1918 map is much more than the conventional "new edition" of the earlier one. It is not possible, in a brief note, to do justice to so elaborate a scheme as that which Köppen brings forward. A careful study of the original paper is essential if an adequate appreciation of the importance and the significance of the new classification is to be gained.

The Scheme of Classification of the 1918 Map

The fundamental zonal subdivision between equator and poles is in six broad belts, distinguished by capital letters, as follows: A, tropical rainy climates; B, dry; C, warm temperate, rainy; D, sub-arctic; E and F, snow. A is the megathermal zone, lacking a winter; C, the mesothermal, or warm temperate; and D the microthermal, with cold winters. Between A and C is the dry zone, B. The tundra belt is E, and the permanently frozen belt is F. These six larger zones are next subdivided into eleven provinces (1-11), beginning at the equator and clearly differentiated on the map by colors, red being used for the warmest, blue for the coldest, yellow for dry, etc.[5] The critical temperature, rainfall, and seasonal characteristics are worked out in detail, and a further scheme of small letters and of exponents is developed which makes possible the use of the series of simple and exact formulae, above referred to, which express the essential characteristics of each climate. Some of these designations are as follows: a = mean temperature of warmest month over 22° C.; h = mean annual temperature over 18° C.; n = frequent fog; n′ = fogs rare, but high relative humidity without rain and relatively cool (summers below 24° C.); s = driest season in summer; w = driest season in winter.

Examples of Climate Characterizations

As an illustration of the simplicity and the completeness of this method of designation we may take the province which includes most of the southeastern United States. This is No. 7 (damp temperate) and is shown in pink. Its formula is Cfa, i. e. (1) the warm temperate belt (C); (2)

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[5] The meanings of the several numbers are as follows:

1. Hot, damp, primeval forest climate
2. Periodically dry savana climate
3. Steppe climate
4. Desert climate
5. Warm climate, with dry winters
6. Warm climate, with dry summers
7. Damp temperate climate
8. Cold climate, with dry winters
9. Cold climate, with wet winters
10. Tundra climate
11. Perpetual frost climate

always well watered, with sufficient rain and snow in all months (f); (3) mean temperature of warmest month over 22° C. (a).

Or, take Yuma. This is No. 4 (desert). Its formula is BWh. This means (1) the dry zone (B); (2) desert (W); (3) mean annual temperature over 18° C. (h).

The Present Reproduction of the 1918 Map

Plate II is a somewhat reduced reproduction, in black and white, of Köppen's colored chart. An attempt has been made to render the symbolism of the color scheme by means of rulings and stipplings. Hot and warm climates are shown in single rulings, semi-arid and arid in stipplings, and cool and cold in cross rulings, the depth of tone decreasing from both extremes of the scale toward the arid desert climate as a minimum. In a very few cases restricted areas of special climatic type, as in higher mountain regions, have been omitted.

Other Features of the Classification

Regarding the names of the various climates, Köppen suggests, as in his earlier scheme, the use of the general terms tropical rain forest, savana, steppe, etc.; of distinguishing forms of vegetation, e. g. oak, birch, etc.; and of descriptive terms such as damp temperate, etc. Again, following the plan of his earlier paper, Köppen shows the ideal geographical distribution of his climates diagrammatically, over a continent stretching from pole to pole. His diagrams include further a comparison of the temperature conditions in the two classifications, the annual migrations of the regions of high and low pressure and of aridity, and the pressure distribution in January and in July over both hemispheres.

Köppen's Comments on Climate and Civilization

The causal interrelations of the various climates are clearly set forth, and, in conclusion, there are some interesting comments on the climates of the geological past, on climate and soils, and on climate and civilization. Certain significant statements are made under the latter headings. For example:

> In the reconstruction of the climates of the past, the less such climates find support in present conditions, the greater caution should be exercised. Assumptions which rest upon a radical rearrangement of the general atmospheric circulation, and on the mean pressure distribution associated therewith, surely need to be supported by strong proofs.

And:

> The oldest civilizations developed in the climates of group B (arid) and on their margins: Egypt, Syria, Mesopotamia, portions of India and of northwestern China in the Old World, and in Mexico and Peru in the New World. . . . . The conditions for the development of these civilizations were found in irrigation, which makes possible a peaceable, well-regulated, and close association of many people, for it insures abundant crops as long as man submits to a well-organized common life and as long as he does not relax in his labor.

From early days, the centers of highest human development have gradually been displaced from the irrigated lands of lower latitudes to the cooler and rainier regions. Many dangers and difficulties are present in a modern highly developed state.

> The development which has led mankind from Babylon to London has in certain respects probably gone too far. On the one hand, it may be observed that too exclusive a concentration upon industry and trade in any country carries with it great dangers, and, on the other, with the aid of modern science and technical skill, we are again coming to practice agriculture under irrigation, instead of in conditions of uncertain natural rainfall. Thus the warm and sunny lands will regain some of the advantages which they have lost to the colder and damper climates, precisely in proportion to the degree with which man's scientific and technical skill succeeds in overcoming the difficulties of transportation and in mastering tropical diseases.

The foregoing comments will serve to indicate the underlying principles which have guided Dr. Köppen in the development of his new classification. No one who makes a close study of the author's discussion and of his map and diagrams can fail to realize how thorough, how systematic, and how *climatically sound* is the scheme. As a framework for studies of the climatic controls over the distribution of life it will prove of great value to students of botany and of zoölogy and to all who are concerned with the relations of man and his geographic environment. Those who are dealing with climates in any of their manifold aspects and relationships will find it a means of systematizing and of correlating their knowledge on a thoroughly scientific climatological basis.